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# The Rise and Fall of the “Personal Equation” in American and British Medicine, 1855–1952

Rory Brinkmann,\* Andrew Turner†‡, and Scott H. Podolsky\*

\*Harvard Medical School.

†The National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care West (NIHR CLAHRC West) at University Hospitals Bristol NHS Foundation Trust, UK

‡Population Health Sciences, Bristol Medical School, University of Bristol, UK

Correspondence: Scott Podolsky, Harvard Medical School, Department of Global Health and Social Medicine, 641 Huntington Avenue, Boston, MA 02115-6019.

Email: Scott\_Podolsky@hms.harvard.edu

**ABSTRACT** Originating within astronomy as a technical term in the first half of the 18th century, the term “personal equation” spread into a litany of other fields including medicine, where it was used widely and variously from the late 19th century to the middle of the 20th century. We explore the personal equation in the medical literatures of the United States and Britain through a systematic analysis of over 700 articles in four prominent medical journals in conjunction with additional relevant source materials. After tracing the term’s dispersion from astronomy into medically allied fields, we examine its striking polysemy while using its rich usage as a lens to examine prevailing tensions within contemporary American and British medicine. Stretching from patient and clinician variability to observer variability and error, the personal equation’s various meanings reflect debates about the art and science of medical care that persist into the present day.

## **The Rise and Fall of the “Personal Equation” in American and British Medicine, 1855–1952**

Medicine today, as both art and science, embodies a split personality. The ensuing tension—between individualized consideration, experience, and judgment on the one hand, and standardization, objective evidence, and guidelines on the other—plays out in the simultaneous aspirations of the medical humanities and evidence-based medicine, and in a host of other telling terms and movements. This is not a new tension, however. We turn in this paper to the critical but complex history of the term “personal equation” as both reflective and generative of this tension on both sides of the Atlantic during a formative period in medicine from the mid-19th through the mid-20th centuries. The term was featured in almost every realm of medical practice, entering prominent medical dictionaries, books, journal articles, orations, and conference proceedings.<sup>1</sup> In clinical, laboratory, and research settings, medical authors at various times considered the personal equation to be worthy of consideration, study, admiration, dread, cultivation, and control. The tension it reflected and engendered remains long after the term has been discarded. As we consider the language we mobilize and are influenced by today (including terms like “personalized medicine”), it is instructive to dig down into the complex manner by which terms can be introduced, invoked, and even discarded by an evolving and ever-complex profession.

Historians of medicine have largely ignored the “personal equation,” while historians of science have principally associated it with the disciplines of astronomy and psychology, leading one observer to claim that the personal equation was rarely used outside of these disciplines (Olesko 2003). In recent years, Jimena Canales (2009) has revised the standard account of the personal equation in the history of science by showing the wide disciplinary breadth of usage of the term (in fields ranging from anthropology to physics and mathematics), opening up the history of the personal equation in a way that has yet to be built upon in the history of medicine.

At the same time, although the personal equation originated in astronomy and appeared

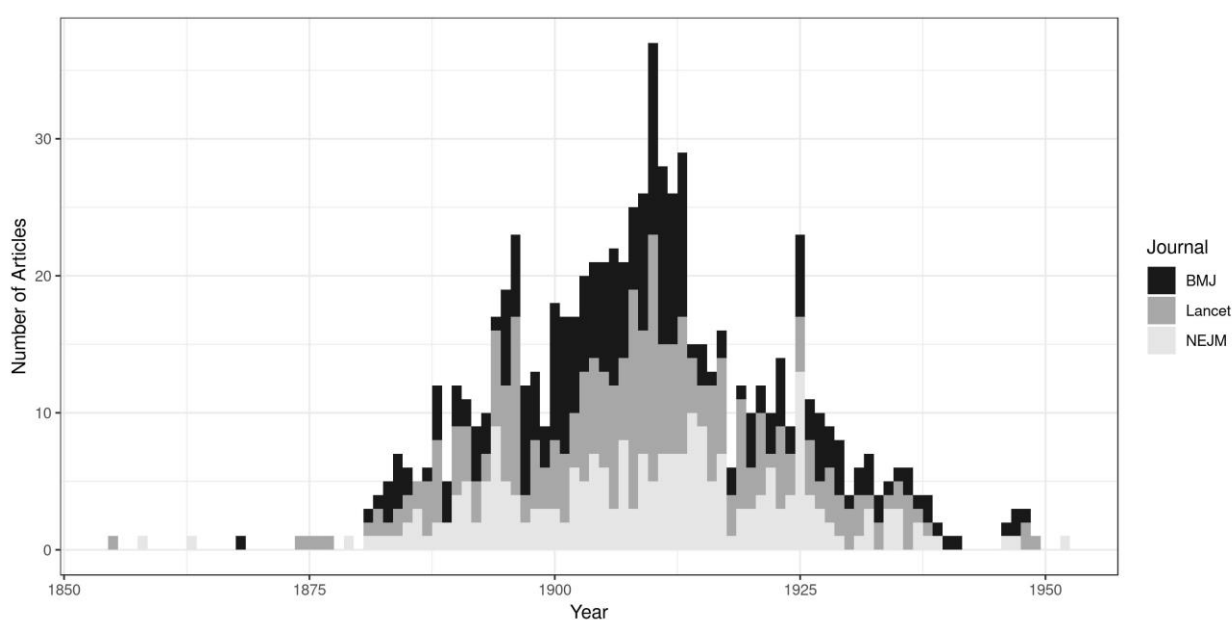
in a number of the exact and inexact sciences, Canales (2009) and Simon Schaffer (1988) have shown that it assumed different trajectories depending upon the disciplinary contexts in which it appeared. As a result, the personal equation in medicine cannot be encompassed within a broader or narrower history of the exact sciences. While doing justice to interdisciplinary exchanges, a medical history of the personal equation needs to be built upon medical debates, practices, and responses.<sup>2</sup>

This makes for tricky work, for while the term was remarkably prevalent, it was also remarkably polysemic—and even polyvalent—within medicine, meaning different things for different practitioners and researchers in different settings (and even within the same speech or article). (For an introduction to such polysemy more generally, see Vanhove 2008.) John Harley Warner (1986, 1991, 2014) has traced the tension in the last decades of the 19th century between a commitment to maintaining the art and humanity of medical practice, and an aspiration to ground medicine in the seemingly objective laboratory science epitomized by physiology and then bacteriology. At stake was the very identity of the profession, and in a forthcoming work, Warner puts the “personal equation” to excellent use as part of an examination of the persisting advocacy in American medicine of “weak knowledge” like clinical acumen and attention to the individuality of the patient in the wake of the rise of seemingly objective, scientific medicine in the last decades of the 19th century (Warner 2019). We would agree that the “personal equation,” in all its heterogeneous uses, serves as an ideal lens through which to examine this tension.

Methodologically, we have grounded our research in the over 700 uses of the term from 1855 to 1952 in four general medical journals—the *New England Journal of Medicine*, the *Journal of the American Medical Association*, the *Lancet*, and the *British Medical Journal*—supplementing such appearances with usage in other contemporary monographs, and medical periodicals when appropriate.<sup>3</sup> While the usage of the “personal equation” certainly needs to be grounded in place and time, we found a remarkably similar usage of the term in both the United

States and Great Britain throughout the time period investigated.<sup>4</sup> We are also aware of the use of the term “personal equation” in French (*l'équation personnelle*) and German (*persönliche Gleichung*) medical settings, though further research on its uses in these and other medical settings requires investigation. As Figure 1 illustrates, the usage of the term peaked in both the United States and Great Britain from the 1890s-1920s; and each shared a similar trend in the meanings and valences ascribed to its usage.

<Figure 1 about here>



This article begins by discussing the origins of the “personal equation” in astronomy in the first half of the 19th century and its application to physiology and psychology, its first and most literal translation into the medical realm. By the latter half of 19th century, the term had ramified within medicine, and we next turn to its usage to denote the inherent *variability* of both patient and clinician, focusing attention upon the art of medical care, and especially upon the role of the individualization versus standardization of care. At the same time, such attention to variability could likewise center upon concerns with *observer* variability in medicine, or what we today consider bias, and the attempt to ground medicine in objective science. The “personal equation” could thus represent, among other things, the differential susceptibility of a patient to

a remedy, the operative preference of a surgeon, or the a priori inclination to view data in a particular manner. What is striking is the degree to which such permutations of meaning existed alongside each other in time and place as medicine wrestled with its very identity. We conclude with considerations regarding the meaning and consequences of such polysemy, the decline of the term by the middle of the 20th century, and the enduring tensions between medical art and science left in the term's wake.

### **Origins and Polysemy in the Hard(er) Sciences**

In 1833, John Pond, at the Royal Observatory at Greenwich, coined the term “personal equation” in response to a puzzling astronomical challenge first delineated by Friedrich Bessel in 1822: namely, that astronomical observers’ star transit measurements differed in an apparently constant manner.<sup>5</sup> To account for these differences in transit calculations, Pond took the average of the differences in measurement between two of his observers and called this average difference the “personal equation” (Pond 1833, iv). Pond’s neologism stood for a description of observer variation, an error correction for such variation, and a measurable quantity. In subsequent decades, these characteristics would be altered depending upon the disciplinary contexts in which the term was used.

The personal equation would ultimately spread from astronomy to a number of fields and popular sources, but it appears first to have entered the discipline of physiology. Before and shortly after Pond’s neologism appeared, researchers had already turned to physiology for explanations of Bessel’s constant differences (Müller 1838–42; Nicolai 1830). In subsequent years, physiologists would continue to investigate the personal equation, joined by those in the nascent discipline of experimental psychology (Canales 2001, 2009; Shamdasani 2003). And as astronomers, physiologists, and psychologists considered it, the personal equation’s striking polysemy began to emerge.

With the development of instruments (such as the electro-chronograph and artificial star-

transit machines) to measure the personal equation directly, a new signification of the personal equation appeared. (For early examples of instruments and methods for calculating the personal equation, see Mitchel 1858 and Wolf 1866. ) Instead of calculating the average differences between observers' measurements, investigators used the instruments to measure individuals' response times to phenomena (or "reaction times"). In such instances, the personal equation lost its meaning as an observer error correction but retained its meaning as a quantification of human variation.

Among psychologists, the personal equation developed yet other significations. It could refer to unquantified errors in observation or interpretation, as when William James stated in 1890 that "the personal equation of the investigator [having] things very much its own way, . . . a savage will be reported to have no moral or religious feelings if his actions shock the observer unduly" (194). In these instances, the personal equation was no longer a measurement and referred instead to qualitative errors that are the result of observer variation; but efforts to account for these errors introduced another nuance. In a 1909 essay, for instance, James described his personal equation so that it could serve as an error correction that his readers could apply to his arguments: he offered "as candid an account of my own personal equation as I can give" so that "the reader will make allowance for it" (285). Carl Jung (1921) and Sigmund Freud (1926), meanwhile, explored the snares and possibilities of the personal equation in clinical settings.

Depending upon context, the personal equation thus assumed different forms and uses, and discussions about it in astronomy, physiology, and psychology were part of larger debates about disciplinary epistemologies and the scientific status of these fields (Canales 2009; Shamdasani 2003). Within medicine, the personal equation's polysemy offers similar insights.

### **Variability and the Art of Medicine**

The relationship of physiology to most medical uses of the term "personal equation" was less

about reaction time than a reaction to what physiology represented: —namely, the aspiration to a standardized, scientific medicine. In this frequent usage, medical authors used the personal equation to challenge such standardization and describe a range of qualitative variations in patients and medical professionals alike.

In relation to patients, Warner (1986, 1991) has described both the degree to which medicine in the United States in particular in the first half of the 19th century was focused on the individuality of each patient, as well as the trend in the last decades of the century away from such individualization. The “personal equation,” as used in this form in every decade on both sides of the Atlantic from the 1870s through the 1930s, demonstrates the persistence of concerns with individual variation well into the 20th century (see also Warner 2019). Medical authors used the term to refer to an array of physiological, psychological, and circumstantial variations among patients and their consequent varying susceptibilities to ailments and interventions alike. While one physician defined the personal equation as “racial, or family, or individual, susceptibility and immunity to certain diseases” (Adams 1897, 587), another pointed to the manifold roles of “habit, occupation, temperament, environment, etc., which are as variable as the features, the manners, the sympathies, the qualities of mind” (Robinson 1904, 417; see also Pearse 1919). Contributors invoking the personal equation could point to the actual “soil on which [a patient] lived” and “the climate in which she dwelt” (“British Medical Association Meeting” 1902, 470), while others could take a more metaphorical stance regarding soil and seed in describing which patients would succumb, for example, to pulmonary infections, as though in direct critique of Koch’s postulates (Squire 1896).

A reductive, quantifiable measurement of the “personal equation” could diffuse into medical settings, as evidenced by a *soirée* at Guy’s Hospital in 1882, at which attendees could each have their “personal equation” determined (“Medical News” 1882, 646). But this appears to have been very rare, and authors frequently considered the personal equation in more holistic terms, standing for the very ineffable variability of patients. Indeed, some were explicitly



skeptical of attempts to measure or quantify patient differences under the name of the personal equation. The *Lancet's* editors stated in 1900 that the “personal equation is a complicated unknown quantity, containing several  $x$ 's. . . . There are hosts of subtle and obscure factors entering into the composition of idiosyncrasy and temperament, which must always vitiate the measurements and reaction-times made on different subjects” (“New Psychology” 1900, 208). Reflecting this pessimism of measurement, one author, writing about susceptibility to infectious disease, claimed that the personal equation “remains and probably ever will remain, unsolved” (Adams 1897, 587), while another, discussing cancer, stated that “the *personal equation* . . . is quite incommensurable” (Marshall 1891, 416).<sup>6</sup>

At times this could lead to a manifest humility, as when one 1920s contributor still held, concerning hay fever inoculations, that physicians should be aware that “there apparently is a personal equation involved in the production of cumulative immunity,” and consequently that “their statements to patients as to the amount and duration of the cumulative immunity should be guarded” (Gould 1926, 934; see also Hodgson 1938). Yet this is not to state that medical professionals could not gain insights into the “personal equations” of their individual patients, even if in a more intuitive manner that reflected hard-earned experience and wisdom, an ethos that persisted into the 20th century (see “British Medical Association Meeting” 1893; “Notes on Books” 1913; “Obstetrics” 1896; Palmer 1904; White 1903). Indeed, in light of the importance of the personal equation in such clinical settings, it is unsurprising that it was put to the task of supporting general practitioners in the face of emerging medical specialism, as when one physician maintained that the family physician’s knowledge of the personal equation, “extending through many years, would enable him to treat and care for [the patient] more thoroughly and successfully, than the new man or any number of special knowledge men” (Palmer 1904, 316; see also Robinson 1902, 1909). Some authors claimed that the ability to gauge the personal equation of patients could be taught (Bradford 1923).

Authors especially advocated attention to patients’ personal equations when discussing

interventions (Sloan 1910). In relation to alcoholism, one author wrote that “the inebriate is a personal equation, each case a personal problem requiring for its solution individual consideration and treatment” (Neff 1912, 913; see also Neff 1914, 1917). Several clinicians noted that consideration of the personal equation of patients before administering anesthesia in particular was crucial. Showing the persistence of the “calculus of suffering” into the 20th century (Pernick 1985), one contributor held that when deciding upon which anesthetics to use, “the personal equation of the patient . . . must enter largely into all considerations of treatment and prognosis” as a “prophylaxis of post-operative complications and discomforts” (“Liverpool Medical Institute” 1906, 1514; see also “Royal Medical and Chirurgical Society” 1904). Often at issue was the belief that the same anesthetic could have different effects upon patients and that anesthesia decisions should consequently not be based only upon the nature of the operation (Buxton 1897; “Lumbar Anaesthesia” 1908; “Notes” 1886; Silk 1894).

The other half of the surgical (and for that matter, medical) equation was likewise an important consideration, as the “personal equation” was frequently used to describe variability among medical professionals. The personal equation was variously deployed to refer to differences ranging from one’s sensory apparatus (vision, smell), to one’s intelligence, knowledge base, beliefs, experience, and overall personality and character (including temperament, sense of independence, and moral disposition) (Bacon 1858; Broadbent 1887; Collie 1913; Crehore 1893; Gage 1905; Keen 1903; Percival and Dudley 1929; Reid 1903; “Reviews and Notices” 1895; Rolleston 1927; “Scholarships” 1907). At one level, such differences could underpin differences in skill, whether in conducting a physical exam, interpreting a test, or diagnosing and treating patients (Bramwell 1899; Ehrenfried 1911; Gage 1905; Knapp 1899; Moore 1922; “Reports of Societies” 1893, 1896; Tileston 1906; Utter 1925). At another level, such differences could underpin the differential judgment of the clinician and the choices he would make in a given situation (Prince 1917; Reid 1903).

In this way, the breadth of the personal equation of medical professionals resembled that

of patients. In a discussion about “the choice methods of hysterectomy,” one physician detailed the “personal equation of the operator” in the following expansive manner:

Some men have learned their art and achieved their distinction by operations in the vagina, while others are better trained in abdominal than vaginal work. The training of the operator then, his possession of all the instruments necessary for the best work in vaginal hysterectomy, his surroundings, the length of his fingers, and even the rules of the hospital in which he operates may have an influence on the choice of operation. (Cushing 1898, 331).

The personal equation of medical professionals was thus an interrelated collection of traits and settings that constituted the individuality of practitioners and consequently created the space for the individual application of their medical art. One author, focusing on “the importance of the personal equation” as it relates to personality, made this clear when he wrote that “attention to this [the personal equation] is the true individualism in medicine which displaces dogmatism and all other isms. It means the influence of the personality of the physician and his recognition of the personality of the patient” (Greene 1898, 362).

As it pertained to clinicians, this was an aspect of care to be acknowledged, reflected upon, and at times even emphasized as clinicians made their decisions and treated patients. It was perhaps emphasized most in discussions of surgical decision-making (“British Medical Association” 1925; “Notes on Books” 1913; “Reports of Societies” 1896; Reynolds 1891; “Séance” 1902). “In surgery,” one contributor discussing abdominal surgery claimed, “the element of personal equation largely determines results—one operator will habitually have a low mortality, another will achieve an occasional brilliant result, while the work of still another will always be mediocre” (Simpson 1909, 1173). Practicing surgeons did not all possess the same abilities, and those less skilled than others could injure patients. In order to manage surgical variability, many argued that interventions should “be decided by the personal equation.” As famed laryngologist Chevalier Jackson (1914) maintained in relation to intralaryngeal

operations, each operator should “select for operation in the particular case the method which suits best his personal equation for that case” (1918; see also “Reports of Societies” 1893).

As such, despite this acknowledged variability, many authors felt reluctant to enact rigid guidelines for surgeons. The “personal equation in operating,” one writer reasoned, “can never be eliminated, nor is it desirable that it should. Each experienced operator must be guided by the results he knows he can obtain and not be tied down to any rule” (DeNormandie 1914, 241).

<sup>7</sup> Another, discussing approaches to appendicitis, observed that “the personal equation of one’s judgment, training and temperament enters so largely into the decision [of which intervention to pursue] that it makes the attempt to formulate any rule which could be safely followed by the profession at large seem well-nigh hopeless” (Gage 1905, 349; see also Barker 1893). The only way to manage the personal equation was to entrust each surgeon with the task of assessing his own personal equation and acting accordingly.

Taken to an extreme, the uniqueness of the clinician—his personal equation as indicative of his unique personality, indeed his charisma—could be described as therapeutic in its own right, as something to embrace and draw upon when treating patients. One contributor noted that “there can be no doubt of the value of the personal equation in gaining the confidence of patients, their relations, and professional brethren. A man should, of course, have the requisite professional knowledge, but he must be able to make full use of his acquirements” (Rolleston 1927, 770). Physicians’ personal equations could charm patients, families, and their own peers, enabling them to be more effective in clinical settings. Writing about overseeing sanatorium patients, one author noted:

The degree of successful supervision either within or without an institution depends almost entirely on the personal influence of the physician himself. It is almost purely a question of personal equation and demands a certain aptitude for the peculiar requirements of the position, a devotion to the work for its own sake, an interested and solicitous regard for the slightest welfare of the patient, a

degree of sympathy, tact and enthusiasm which may almost be said to constitute a form of genius. (Bonney 1902, 1438).

In these situations, practitioners believed that the personal equation of physicians was a form of treatment in and of itself (see also Warner 2019). As another physician noted in 1918 in relation to caring for soldiers suffering from nervous disorders, “the results of treatment depended, above all, on the personal equation of the medical officer in charge more than upon the exact methods of treatment relied upon” (“Medical Societies” 1918). Charismatic physicians could induce real improvements in their patients (Folsom 1890; “Reviews of Books” 1948). Given the importance of the clinician’s personal equation, some authors argued that it should be actively shaped. William Osler claimed in a 1903 address that “as the practice of medicine is not a business and can never be one, the education of the heart—the moral side of the man—must keep pace with the education of the head. . . . After all, the personal equation has the most to do with success or failure in medicine” (276).

And yet, by the first decades of the 20th century, such clinician variability was already deemed a threat to the aspirations of those who would standardize and rationalize care. In 1915, two years after the establishment of the American College of Surgeons, Boston University’s Walter Wesselhoeft decried the variability evident in the inpatient setting. Speaking on the barriers to “hospital efficiency,” he stated:

There is but the one remedy in sight, the framing of rigid rules and their faithful observance . . . . By these means many errors might be eliminated, many a doubtful course replaced by a better one and the rising generation drilled in the art of observation which now leaves much to be desired. It would mean a mighty reform in therapeutics and by the comparative method, minimize the effects of the personal equation of the individual physician, and establish in time the merits of old and new methods. The scientific method, that based upon the fundamental principles of science, is no mere generality. It is the sole umpire between

opposing measures and methods. So long as doctors differ (and in our hospitals as elsewhere, they will always claim the right to do their best in their own way) there must be found a way of differentiating the better from the good and the good from the bad. (778).<sup>8</sup>

Variability, in Wesselhoeft's vision of the future, was to give way to standardization, as the personal equation was to be minimized, if not eliminated. Moreover, in parallel, the "art of observation" itself was considered by others in need of disciplining, as the personal equation of observers received its own critique.

### **Observation and Medical Science**

While the personal equation as patient or clinician variation found wide usage in medical discussions, the personal equation as observer error—frequently distinguished as "the personal equation of the observer" (Balfour 1882; Broadbent 1887)—found equally wide usage.<sup>9</sup> These two usages were not distinct, for the personal equation as error drew its meaning from practitioner variation; but observer error became an important association over time in both the United States and Great Britain, as when the 1897 inaugural edition of George Gould's *Illustrated Dictionary of Medicine* described the "personal equation" as "an allowance for individual peculiarity or error in an observer's work." . This usage drew from the term's original astronomical associations to denote the possibility for observer error at all levels of assessment and categorization. Authors wrote about these errors in stark terms. The personal equation as observer error was "much dreaded" and "vitiat[ing]," had a "disturbing influence" on medical knowledge, assumed "great importance as a possible source of error," and was "an obstructive factor in scientific study" (Bowditch 1900; "British Medical Journal" 1895; "Reports of Societies" 1885; "Review" 1907; "Sixty-Fifth Annual Meeting" 1897). In a 1926 address, the French physician D'Arsonval went so far as to cast the history of medicine as a battle to reduce the influence of the personal equation (Chauvois 1937; see also Canales 2009).

But the personal equation as observer error was generally portrayed in qualitative, rather than quantitative terms, pointing to the manifold forces behind such error and the need for skepticism in assessing facts and statements. Consider John Shaw Billings's suggestion in 1886:

Almost all men suppose they think scientifically upon all subjects; but, as a matter of fact, the number of persons who are so free from personal equation due to heredity, to early associations, to emotions of various kinds, or to temporary disorder of the digestive or nervous machinery that their mental vision is at all time achromatic and not astigmatic, is very small indeed. (561).

A year later, discussing blood pressure measurement, William Broadbent (1887) would display the skepticism underlying such usage in a lecture before the Royal College of Physicians of London: "The personal equation of the observer therefore comes in, and if any special result is greatly desired, an enthusiastic investigator can obtain it, and may without the least conscious intention twist facts in the required direction" (609; see also "Personal Equation" 1909). To our surprise, we only found a single instance of expressed concern over the impact of commercial forces on the workings of the personal equation ("Examination" 1908).

The personal equation as observer error could operate at multiple levels. It could interfere with the grading of symptoms and with the physical exam, as demonstrated in situations ranging from cardiac and pulmonary auscultation to blood pressure measurement ("Edinburgh Medico-Chirurgical Society" 1910; "Royal Medical and Chirurgical Society" 1903; "Reviews and Notices" 1913; Sansom 1898; Utter 1925; Wernich 1907). It could interfere with the interpretation of adjunctive tests, from laboratory assessments like the enumeration of leukocytes and immunological tests like the Widal reaction and opsonin determination, to emerging technologies like x-rays, which could be portrayed at one point as overcoming the personal equation and another as serving as an entry point for an entire new range of variable interpretations of seemingly objective data (O'Brien 1916; "Value of Opsonic Determinations"

1907; Wassersug 1947; Wynne 1914; “X Ray Work” 1906). It could interfere with the diagnosis and classification of diseases ranging from tuberculosis to alcoholism, in locations ranging from the clinic to the pathologists’ chambers (Mixer 1921; Neff 1915; “Reviews and Notices” 1905). And it could certainly interfere with assessments of therapeutic efficacy, to the point that several observers specifically listed “death” as the one outcome assessment not susceptible to the personal equation (Kenney 1922; Moorhead 1922; Turner 1908).

The personal equation could operate through many types of observers. Medical school examiners could carry such baggage into their evaluations of students, while medical illustrators and expert witnesses could have their judgment clouded (Crehore 1893; “Examiners and Examinees” 1896; “France” 1932; Gay 1909; Gould 1887). Patients themselves, already “variable” in their constitutions, complicated things still further by bringing their own observer variation into the equation, ranging from their faulty memories (“Smallpox Infection” 1904) to their differential reporting of degrees of symptoms. (The lines between different forms of “variation” blur here; see Austin 1928; Scudder 1901. ). And there was nothing to preclude observer variation from taking place at various levels of clinical evaluation at the same time. This could apply to the assessment of symptoms, as when a surgeon evaluating leg claudication stated that “it is obvious that terms such as ‘good,’ ‘fair,’ ‘improved’ depend too much on the personal equation of both patient and surgeon to be of much value as clinical records” (Simmons 1936, 74). And it could pertain to the physical exam, as when one examiner of patients’ visual fields reported: “The personal equation of the examiner multiplied by the personal equation of the patient equals the result” (Lancaster 1913, 879). Indeed, T. L. Stedman’s 1913 edition of *A Practical Medical Dictionary* defined the personal equation as “a slight error in judgment or action peculiar to the individual” and as “the factor of individual differences to be reckoned with in studying the results of experiments . . . ; this is to be considered in both the experimenter and the person experimented upon.” In *An Index of Symptoms as a Clew to Diagnosis* (1904), Ralph Leftwich similarly wrote, “The fallacy of the



personal equation—This is of two kinds: that of the physician and that of the patient.” (20) <sup>10</sup>

The “personal equation” of the observer appeared concurrently with the term *bias* in Anglophone medical journals. <sup>11</sup> The terms have very different origins. Whereas the “personal equation” originated as a technical astronomical term, *bias* emerged centuries earlier as a colloquial term. Indeed, *bias* would only become a technical statistical definition in the first half of the 20th century, and so depended upon its popular definitions in its usage in 19th-century medical journals (we have likewise only been able to find *bias* in medical dictionaries from the middle of the 20th century, though it is also clear to us that the term’s entrance lagged behind its usage; see, for example, Blakiston 1949). Despite these differences in technical and lay origins, the personal equation of the observer and *bias* largely overlapped in their medical meanings. Indeed, in some cases, the two terms were equated, as in an article discussing the typology of tuberculosis that held a classification “should depend upon easily obtainable facts, and be free of any possibility of variation due to the personal equation or bias of the classifier” (Wingfield 1916, 1057). When the two terms were distinguished, it was largely because medical authors used the personal equation to signify something other than observer error (Bonney 1902; Emerson 1882; Stedman 1897). The contemporaneous usage of the personal equation of the observer and *bias* might best be understood as a general resonance and merging of meanings that anticipated the technical definitions of *bias* that became so prominent in 20th-century medicine (and that, as discussed below, likely contributed to the disuse of “personal equation” by the mid-20th century; for an example of this merging in the statistical literature, see Yule 1906).

Those who focused on the personal equation of the observer often did so in the service of a particular conception of scientific objectivity that gained prominence in the 19th century. In an examination of medical illustrations, for example, a Massachusetts physician made a distinction between the “subjective method” of drawing and the “objective method” of photography (Crehore 1893). The key difference between these two methods, he suggested,

hinged on the influence of the personal equation. In drawing, the “personal equation comes into play,” while photography keeps the “error due to personal equation . . . within comparatively narrow limits.” (379). To gain objective knowledge is to eliminate the idiosyncrasy among observers, including their “optical sense,” “broad field of imagination with preconceived notions and expected appearances,” and “technical skill.” While drawing is subjective and ridden with errors—“the observer records with his pencil what he sees or thinks he sees, or (perhaps) what he wishes to see”—the photographic method is objective because observers and their personal equations are removed, offering “an impartial view of the object, made by *itself*.” In the reduction of subjectivity, wrote another physician, one’s “personal equation must be reduced to a minimum and . . . he must lose himself in order to think wisely and judge well for others” (Blake 1900, 482). Or as an author who spoke of the need “to eliminate the personal equation” in medical statistics put it in 1912, “science should always be impersonal” (“Statistics,” 941). In contrast to scientific knowledge, knowledge tainted by the personal equation rested on the “quick sands of mere opinion” (Beaumont 1888, 152).

This understanding of scientific objectivity was by no means peculiar to the medical community. Lorraine Daston and Peter Galison (1992, 2007) have traced the rise of “mechanical objectivity” in the 19th century as both a concept and a virtue that extended to many scientific fields. They have used the shifting content of anatomical atlases to illustrate the advent of mechanical objectivity within medicine, and indeed, as the effects of mechanical objectivity were felt in the medical community, one of the fault lines along which it operated was the “personal equation.” The effort to eliminate the personal equation in medicine was thus part of a much wider attempt to produce objective knowledge and make medical practices align with the epistemic norms of other scientific fields (see also Warner 2019).

However, the conflict between mechanical objectivity and the personal equation in medicine did not follow a template that was laid out by other disciplines. In astronomy, for example, personal equation errors were confronted by quantitative error corrections,

reorganizations of institutional hierarchies, and specific observational instruments (see Schaffer 1988). Within medicine, there was no clear consensus about how to curtail the effects of the personal equation of the observer, and any teleological sense of inevitable movement towards the blinding of researchers and patients is offset by the historical heterogeneity of responses and approaches taken throughout this period.

The most fundamental response was simply the stated recognition of the role of the personal equation, resulting in an expressed humility, skepticism, or even cynicism, a reminder to consider one's sources when confronted with supposed statements of fact. It was in this manner that Patrick Manson (1896), discussing a report concerning perceived malarial forms in the blood, maintained: "The personal equation has to be discounted in assessing the value of all observations, particularly all microscopic observations . . . . [One should] know something about the capacity and character of the person who makes it" (1821). Billings (1886) similarly claimed that "it is necessary . . . to apply a correction for personal equation to each individual set of opinions before its true weight and value can be estimated" (565). Horatio Storer (1863), studying rates of abortion, invoked the personal equation in considering observers' "general accuracy, their weight as authority, and the purpose, more especially, for which the observations were made" (19).<sup>12</sup>

From the other end, in order to anticipate readers' concerns about observations and the arguments they supported, medical authors could broadly testify on behalf of their observers and their attempts to have minimized the personal equation. One writer claimed that the observers in his study of renal albuminuria were "competent to distinguish mucous from renal casts" and that "the personal equation can [thus] be eliminated from my results" (Shattuck 1894, 614; see also "Reports on the Hygienic Condition" 1897). Other authors would acknowledge the presence of the personal equation of observers or patients in their studies but claim, in unquantified ways, to be able to deduct it from their conclusions (Bowman 1924). Yet there were obvious limitations to such qualitative error corrections. Even granting that one could possess

knowledge of an observer's personal equation, there was still the question of how to apply this knowledge to the observations themselves. As Billings noted, "no general formula for this purpose has yet been worked out" (Billings 1886, 565).

Despite this absence of general corrective formulae, however, a number of approaches to controlling for the personal equation were offered (while many of these measures were employed, some were only proposed in a more aspirational sense). Controlling the number of observers was one frequently invoked measure to combat its intrusion, as a single observer could seemingly offer more uniform and reliable information than could multiple observers (Belding 1922; "Case 13291"; Clark 1895; Spangler 1916; Vercoe 1926). While this may seem paradoxical to 21st-century readers, behind this measure was the belief that mixing the personal equations of more than one individual could jumble the impacts of variation on observations, making it difficult to extract meaningful knowledge (Cotton 1899; "Miscellany" 1924; Smith 1928). And it certainly seemed to apply to observations made over extended durations of time. A contributor discussing deaths by illuminating gas applied this reasoning when he wrote, "we are fortunate in having competent men who have served for many years in the same capacity; hence their observations have been standardized over a period of years and the personal equation being unvarying, the other factors would tend to show the true state in the community in regard to deaths" (Sword 1928, 981; see also "Royal Society of Medicine" 1921; "Scotland" 1926; Spangler 1916; Whyte 1910).

In contrast, certain authors invoked the use of multiple observers, to keep personal equation errors at bay by having observers crosscheck their observations or reach a consensus. For example, a group of authors claimed that in their study of diphtheria, "the personal equation has been eliminated by three persons making the examinations with checking of results" (Geiger, Kelly, and Bathgate 1916, 645). An author studying tuberculosis similarly "endeavored as far as possible to avoid the much dreaded and much quoted 'personal equation' in giving results which have been corroborated by others" (Bowditch 1900, 129). Crosschecking results

could also blur into deference to an authoritative observer, as when another investigator of tuberculosis stated that “in order to remove the personal equation, Dr. P. Challis Bartlett, who for three years was superintendent of the Rutland State Sanatorium, has kindly gone over the records” (Pratt 1917, 15; see also Oliver 1896b; Williamson 1907). Similarly, researchers could compare one set of results to those obtained independently by others. Richard Cabot (1911a), studying disease prevalence in Boston, argued that “the three sets of figures worked out separately were found to tally very closely. This tends to show that the personality of a given group of house officers on whose questions the data are based cuts no considerable figure in the results” (159). Another researcher wrote that the grading of body mechanics by “several physicians was remarkably uniform and while there was undoubtedly individual variation, the factor of personal equation seems to have been very slight” (“Use in Foods” 1909, 321; see also Berkeley 1925; Brown 1920; Halliday 1935). In clinical settings, second opinions might be used to counterbalance or check for the effects of a physician’s personal equation (“Notes” 1919).

Such use of seemingly independent observers could likewise be performed prospectively, as when instead of having observers reach a consensus, authors would rotate observers so that their individual personal equations would be counterbalanced. In a discussion of blood pressure measurements performed by two observers, one author stated that “for alternate observations the two observers changed about so that the one who had previously taken the arm reading now took the foot one, and *vice versa*, the object of this procedure being to eliminate any personal equation” (Williamson 1917, 14). Similarly, in a discussion of medical officers’ infectious disease observations in the Royal Navy, another contributor stated that “the personal equation of medical officers is neutralised by the fact that those serving on one station in one year are serving on some other within the next three years.” (Dudley 1931, 509). It was likewise in this context of concern over the role of the personal equation—and attempts to dilute its individual influence—that several societies turned to collective investigation (Marks 2006; Moffet 2017). Addressing the Colorado State Medical Society in 1889 about collective

investigations of the effects of climate on tuberculosis, one contributor reflected that “to relieve them [the investigations] from the element of the personal equation which an individual’s writing must always bear, this Society voted last year to entrust a consideration of this question to a ‘Committee of Collective Investigation,’ which should have power to solicit reports from individual members of this Society” (Fisk 1889, 173). Regardless of the number of observers, researchers often proposed that increasing sample sizes of interventions could also diminish the personal equation’s effects, whether owing to operator variability in procedures, or observer variability (“Ultra-Violet Irradiation” 1924; Douglas 1925; Greenwood 1948; Richardson 1889).

In addition to controlling the numbers and interactions of observers, medical authors also believed that standardizing methods of data acquisition could limit error from the personal equation (“Report” 1896). Authors argued that standardized methodologies could make the personal equation constant across observers, such as when Richard Cabot (1893)—discussing leukocytosis as an indicator of pneumonia—stated that “in order that the influence of the personal equation might be as nearly as possible the same in all cases, an exactly identical technique [of drawing and preparing the blood and enumerating the cells] was used in all” (117; see also Sullivan 1912).

Authors’ arguments for the adoption or standardization of methods hinged upon the belief that certain practices “disciplined” observers, to use Schaffer’s use of the term. These sources of discipline could refer to the sequence and timing of laboratory steps, particular classification schemes, and procedural rules, such as adequate thresholds necessary for particular positive identifiers (“Abstract” 1902; Codman 1905; “Control of Venereal Diseases” 1916; Emery 1918; Jameson 1932; Miller 1937; “Standardisation of Disinfectants” 1908; Smith and Solomon 1917). In clinically oriented work, they could refer to the positions in which patients should be placed and to different forms of physical examinations (Oliver 1896b; “Reviews and Notices” 1913;). Authors also argued that training or experience in a particular method could improve a method’s effectiveness at limiting the effects of the personal equation (“Association of

Clinical Pathologists” 1933; “Disposal of Dysentery Carriers” 1919; Sullivan 1912).

In addition to prescriptive methods, authors argued that in certain instances, mechanical devices—technologies—offered clinicians and researchers a way of subduing or eliminating their personal equations. This response to the personal equation resembles the mechanical solutions sought by astronomers and physicists, such as the “impersonal micrometer” (Canales 2009, 151). Contributors invoking the personal equation acclaimed various medical instruments as “constant,” “uniform,” or automatic (Herschell 1896b; Oliver 1896a; “Pulse-Rate and Arterial Tension” 1913). In an 1881 address, Billings referred to this hope for medical devices when he stated that

the balance and the galvanometer, the microscope and the pendulum, the camera, the sphygmograph and the thermometer are some of the means by which investigators, at the bedside and in the laboratory, are seeking to obtain records which shall be independent of their own sensations or personal equations; which shall be taken and used as expressing not opinions, but facts.  
(270)<sup>13</sup>

Authors frequently drew a sharp distinction between knowledge derived from mechanical devices and other methods ostensibly more susceptible to the personal equation, characterizing the latter as opinions or, as one author who placed his faith in diagnosing chronic appendicitis in x-ray imaging stated, as “founded on sand” (Austin 1928, 1465).

At the same time, many also recognized that the interpretation of the outputs of medical devices ranging from sphygmomanometers to x-rays to electrocardiograms were not immune from the personal equation’s influence (Amblard 1921; Chapman 1894; Wassersug 1947). As the director of the Bureau of Standards of the Department of Commerce summarized in a *JAMA* letter to the editor, “it should be remembered that no instrument can be made absolutely accurate, and that even if it could, the personal equation of the user would still be a source of error” (Shatton 1919, 1383; see also Chapman 1894; Tirard 1909).

Finally, several authors, on both sides of the Atlantic, seemingly independently employed what would eventually be termed “blinding” to prevent observers from gaining knowledge about subjects that might cause their personal equations to compromise their study (on the first uses of the term in this manner in the medical literature in the 1910s, see Shapiro and Shapiro 1997). In an investigation of leukocytes in tuberculosis patients, a pair of authors ensured that “the one who examined the blood knew nothing about the patients, or what they were getting, or how they were affected, or when they began or ended treatment,” with an aim “to eliminate the personal equation as much as possible” (Solis-Cohen and Strickler 1911, 569; for related efforts, see Barr 1922; Dreyer, Bazett, and Pierce 1920; Goadby 1905; Johnston-Lavis 1910; McDowall 1912). Blinding to decrease the personal equation’s effects was not only used to conceal patient information from observers. It was also used to prevent observers (and occasionally patients) from recalling previous clinical assessments. In a study of hyperalgesia using a pin to map sensitive abdominal areas, the second time the procedure was performed “both the patient and the operator [kept] their eyes away from the pin, so as to eliminate as far as possible the personal equation in the examination” (“Epitome” 1909).<sup>14</sup> More skeptically, in an assessment of the accuracy of percussion of the heart as a measurement of the Nauheim (bath) treatment of heart disease, a critical author encouraged his reader to demonstrate to himself that the personal equation affected heart percussion:

“All he has to do is to blindfold himself and make out upon a given case the upper limit of relative cardiac dulness [sic], marking it upon the surface of the chest with an aniline pencil. Let him do this several times in succession at intervals of a few minutes marking each time. When he removes the bandage from his eyes he will find that the result is a series of lines at short distances from each other upon the chest, some of them intersecting the others”. (Herschell 1896a, 414).

Perhaps most strikingly, in the realm of therapeutic assessment, researchers could



combine methods meant to ensure fair comparison of treatment and “control” groups (such as the strict alternation of patients to treatment versus no-treatment groups) with such blinding to ensure the objective evaluation of treatment outcomes (see Chalmers et al. 2012). In 1913, Michigan’s A. W. Hewlett noted specifically with respect to therapeutic trials:

The personal equations of different observers, the tendency to bias, differences in the modes of administration, in the doses employed, and in the cases selected for treatment, all tend to obscure the significance of reported results. In order to obtain trustworthy data, it is necessary that a considerable number of observations on patients should be made under conditions which eliminate personal bias and reduce to a minimum the errors inherent in statistics. (319)

Hewlett himself, in his investigation of natural versus synthetic sodium salicylate for the treatment of a number of ailments (sfever, pain, delirium), supplied the remedies in coded boxes to 82 investigators, keeping them ignorant regarding which remedy each box contained, and ultimately finding the two remedies equivalent. In Hewlett’s hands, the variability of the patients and their treatments—the “personal equation” as “cases selected for treatment” and as “modes of administration” of remedy—was offset by the random assortment of patients to various treatment groups. The “personal equation” as observer bias was offset by the ignorance of the clinician-evaluators as to which remedy they had in fact employed. As such, the “personal equation” would serve as a bridge to 20th-century attempts at both randomization and double-blinding alike.

### **Polysemy and the Decline of the “Personal Equation”**

What is perhaps most striking about the invocation of the “personal equation,” however, was its heterogeneous application in real time, reflecting enduring tensions regarding the relative roles of art and science in medicine. The term’s very polysemy reflected such underlying tensions. William Osler may have used it in 1903 to refer to the artistry of the clinician, but in 1885, Osler

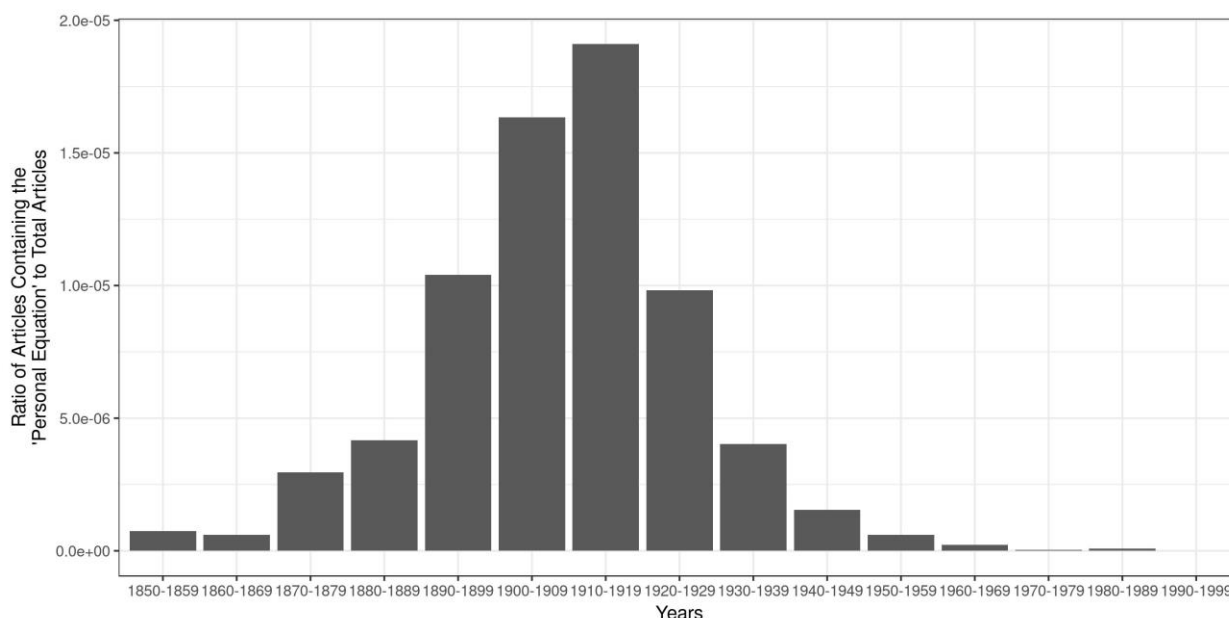
had stated of Nathan Smith Davis's failure to recognize the cardiac stimulatory effects of alcohol: "Place this negative statement against the very positive assertions of so many other observers, and we have an illustration of how difficult it is to get at therapeutical truth, and how much must be allowed for the 'personal equation' in the observer" (178). We see such polysemy still more dramatically in the multiple instances in which the "personal equation" was used multiple times in multiple senses in the same talk or article (see, for example, Gardner 1908; Mumford 1905; Pemberton 1925; "Reports of Societies" 1908). In 1891, surgeon Lawson Tait, writing in the *Lancet* about the "treatment of chronic inflammatory disease of the uterine appendages," noted how the "personal equation" of clinicians affected the manner by which they classified conditions (as inflammatory or not) in the first place, while "a personal equation of another kind seems inevitably to step in the moment the operation of removal of the uterine appendages comes to be discussed" (573). Two decades later, and across the Atlantic, Richard Cabot (1911b) attempted to create a more natural space for the two domains, stating: "Whereas in the laboratory one's constant effort is to reduce the personal factor, the personal equation, to a minimum, to remove from the field of vision all elements due to one's personality, and to make oneself so far as possible passive before the phenomena we are trying to record, the opposite is true of every successful clinician" (881). This could entail some significant mental shifting in the clinic, especially if one considered the physical exam an extension of such objective data gathering, prior to the consequent administration of therapeutics: "In my own work I have often felt a sort of wrench as in dealing with patients I have turned from the activities of physical diagnosis with their strenuous efforts at impartiality and passivity, to the field of active therapeutics in which one succeeds only by being partial, not impartial, by taking chances and by the presence of contagious hopefulness." But the space between art and science was often contested, this very tension reflected in the multiple uses and meanings of the "personal equation" by physicians throughout a period of significant medical reorientation of practice and identity (Warner 1986, 1991, 2014).

As late as in 1934, John Rockwell reminded the hospital staff and graduating interns at the Massachusetts Memorial Hospitals that in treating patients, they “should manifest a greater regard for the personal equation and a sympathetic interest in the family’s needs, in the broadest sense, so that [one] can truly practice the art as well as the science of medicine, with equal facility” (427). But the penultimate usage of the term in *NEJM* (Wassersug 1947) and final usage in *JAMA*, both concerning the interpretation of chest x-rays, clearly referred to its role as observer bias, a hindrance to modern medicine and the application of its technologies. Writing in 1947 about “the ‘personal equation’ in the interpretation of a chest roentgenogram,” and the tendency for separate observers to vary in their interpretation of the same chest film (and for the same individual to offer varying interpretations of the same film on separate occasions), *JAMA*’s editors lamented: “Error resulting from the ‘personal equation’ exists in all fields of knowledge. . . . There has been a tendency to assume that roentgenology is an exact science and that the objectivity of the medium defied error. Complacency has been a consequence of such assumption” (399).

This would be the personal equation’s last appearance in *JAMA*, however, and by the middle of the 20th century, the term would largely disappear from the popular and medical literatures alike. Its disappearance does not seem to be the result of explicit purging within clinical medicine. Physicians and physiologists occasionally did offer critiques of the term’s polysemy, as when one Dr. Sexton observed in 1906 that “the term ‘personal equation’ has always been to me very ambiguous and . . . I would dislike very much to be suddenly called upon to give a definition of it in good plain English” (“Discussion” 1906, 101).<sup>15</sup> However, it must be emphasized that critiques along these lines appear to have been exceedingly rare in the medical community. Instead of being actively eliminated because of its polysemy, the decline of the personal equation seems related to a combination of factors. Beyond the field of medicine, the personal equation became a less prominent term in the exact sciences. Due to the success of strategies for removing the personal equation from observations in fields such as astronomy

and physics, the once daunting personal equation appears to have become less of a concern (Canales 2009). Within popular culture, the term likewise declined during this time (Figure 2), though the relationship between such usage in the popular and the scientific and medical cultures requires further investigation.

<Figure 2 about here>



Within medicine, it appears that as researchers and statisticians felt increasingly confident in their capacity to eliminate the personal equation from research, they seemed increasingly comfortable with eliminating the term itself from their talks and writings. When the personal equation had entered medical discussions, it had often been cited as a reason for why medical statistics could not be trusted. Authors invoking the personal equation wrote of “the fallaciousness of medical statistics” (Storer 1863, 20) and made claims such as that “it is only too well said that [statistics] can be manipulated to prove pretty much any position one cares to take” (“Statistics” 1912, 941). Behind this distrust was the belief that the inquiries producing the statistics depended “too largely for accuracy upon the personal equation of countless patients and numerous physicians” (Mumford 1905, 236; see also Taylor and Myer 1903). Yet from the first decades of the 20th century onward, statistics became a means of curtailing error, the

personal equation among them. A *Lancet* editorialist stated in 1923: “[If] statistical methods can be brought to bear [on medical research], in order to ascertain what common truths have emerged, every aspect of cancer research will gain in clearness. The variety of environment, or the variety of personal equation in the investigations, can be made allowance for” (“British Empire Cancer Campaign” 1923, 1117; see also Clark 1913). Statistics ceased to be simply descriptive and instead came to refer to a host of methodologies that could guard against various errors that originated from human variation (Daston, Heidelberger, and Krüger 1987; Stigler 1990), while medical statistics gave the medical profession a new vocabulary to describe human variation and observer errors, such as the technical statistical definition of bias.

As it lost its utility to denote observer variability, the “personal equation” appears to have fallen out of favor as a means to discuss patient and clinician variability as well. There is no obvious cause for this decline, and we are forced to wonder if its very polysemy and imprecision may have contributed to its more general decline as a seemingly useful term. This is not to state that concerns about holism versus reductionism, art versus science, or judgment versus standardization would disappear from the medical literature. On the contrary. The 20th and 21st centuries would witness enduring debates aligned along such axes. Concerns regarding the “personal equation” would be replaced by musings about the biosocial or psychosomatic aspects of patients and their ailments from the one end, and about standardization, judgment, medical humanism, and the caregiving role of the provider from the other. The personal equation may have been eliminated from the literature, but the tensions it reflected and highlighted persist within medicine and its literature today.

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#### <Footnotes>

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<sup>1</sup> The “personal factor” and to a lesser extent “human factor” were largely synonyms for the “personal equation” throughout this time period. The personal equation also appeared in the popular writings of physicians, such as in Arthur Conan Doyle’s “Musgrave Ritual” (1900).

<sup>2</sup> In the first decades of usage of the term “personal equation” in medical journals, several authors did directly acknowledge their borrowing of the term from astronomy. For example, see Bacon 1858; Crehore 1893.

<sup>3</sup> The *New England Journal of Medicine* was called the *Boston Medical and Surgical Journal* from 1828–1928, and its pre-1828 history entailed still other name changes and amalgamations. *NEJM* has run from 1812–present, *JAMA* from 1883–present, *Lancet* from 1823–present, and the *BMJ* from 1840–present. The online searches used to trace usages in the four journals (using their interfaces) respectively occurred on the following days: 13 June 2016, 16 June 2016, 11 July 2016, and 16 March 2017. Note that *JAMA*’s full-text search functionality has been significantly truncated since moving to a new platform in recent years, yielding an incomplete search outcome. Note also that such usage is only a representative sample of a term that was used widely on both sides of the Atlantic.

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<sup>5</sup> Bessel began his investigations in 1815, but his first publication on the topic of constant differences occurred in 1822. There is some confusion about the origins of the term “personal equation.” For a persuasive discussion crediting Pond with the neologism, see Hoffman 2007.

<sup>6</sup> This vein of skepticism could manifest itself as derisive criticism of physiological and psychological measurements with respect to the personal equation (“The New Psychology”). When the endocrinologist Louis Berman published *The Personal Equation* in 1925, in which he claimed to be able to discern the endocrinologically derived personal equations of historical figures, medical reviews pilloried the book for its seemingly reductive explanations.

<sup>7</sup> This applied to anesthesia as well. One contributor who felt he could not “add anything to the scientific side of the gas-oxygen question” appeared content with his artful management of his own personal equation. He stated that “the important thing” in administration of “gas-oxygen” anesthesia was “the personal equation of the man who gives it,” adding that “I cannot explain how I know that patients are in danger, but the expression of the patient, the look of the patient, gives one warning” (Ehrenfried 1911, 597).

<sup>8</sup> Regarding earlier concerns along these lines, pertaining to anesthesia, another author was derisive of “the fancy, the prejudice, or the opinion—call it what you will—of the administrator” of anesthesia in general. He believed that those who depended on it “wander aimlessly along without having any firm ground on which to walk.” Instead, he called for the removal of the “‘personal equation’ altogether,” exclaiming that “it behoves us not to rest content until we can give a scientific reason” (Beaumont 1888, 152).

<sup>9</sup> In an analysis of the usage of “personal equation,” we found the ratio of the personal equation as variation (with no association with error) and the personal equation as error to be 1.14 (or 107: 94) in *NEJM*, 0.69 (or 109: 159) in the *Lancet*, and 1.25 (or 121: 97) in the *BMJ*.

<sup>10</sup> Such concerns with both subject and observer would foreshadow the enunciation of the need for “double-blind” testing in the 20th century; see Podolsky, Jones, and Kaptchuk 2016.

<sup>11</sup> The term *bias* precedes, parallels, and (of course) survives the “personal equation” in medical journals.

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For example, the first instances of *bias* in the *NEJM*, the *Lancet*, and the *BMJ* are from 1813, 1823, and 1840 respectively. The first instances of the “personal equation” in the same journals are from 1858, 1855, and 1868 respectively.

<sup>12</sup> Belief in the importance of this form of correction could cause consternation at the prospect of anonymous works, as when one book reviewer in the *Lancet* bristled at an unattributed publication, writing that “an anonymous scientific work must possess strong intrinsic merit before it can command acceptance at the hands of those who are in the habit of gauging every written statement by the known personal equation of the author” (“Association of Clinical Pathologists” 1933, 1069; see also Emmons and Powers 1916; Manson 1896).

<sup>13</sup> A measure of the trust placed in mechanized devices can be gleaned from observers who styled themselves as machines; see. ., Harman 1904. The rise of the sphygmomanometer over previous methods provides a particularly frequent illustration, as when one author wrote of a recording sphygmomanometer, “this latest development in the mechanical determination of blood pressure enables one to do away entirely with the stethoscope, palpating finger and indicating hand, thus eliminating completely the personal equation, and further gives a permanent record of unquestioned accuracy” (Barr 1927, 1513). See also Franz 1907; Porter 1909; “Royal Medical and Chirurgical Society” 1903.

<sup>14</sup>

<sup>15</sup> Sexton’s observation was in response to J. D. Patterson’s paper titled “The Personal Equation” (1906). Another physician . who was in the room, Dr. Nyman, ventured to address Sexton’s uncertainty by defining the personal equation as “individual variation” (“Discussion” 1906, 104). Sexton was not alone in his confusion. The physiologist A. M. Bloch (1884) complained that the preponderance of usages for the personal equation caused “vexing [*fâcheuse*] confusion” (33). While Bloch defined his usage narrowly as a result, Sigmund Exner (1873) simply jettisoned the term, despairing of its variety of meanings and instead coining the phrase “reaction time” in an attempt to bring some clarity to physiological research. For a discussion of Exner’s work in relation to astronomy, see Canales 2001.